Research on Active Solar Processes During 2019 July 2 Total Solar Eclipse

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Abstract.

We live in an era where scientific studies of the Sun and the solar-terrestrial interactions, being done by ground-based and orbital observatories, are more improved and wide-spread. However, the total solar eclipses are still a cosmic laboratory impossible to simulate on Earth and they provide a chance for detailed studies of the corona and the active processes which affect our everyday lives.

Our research team is preparing an expedition to observe a total solar eclipse on 2019 July 2 from Chile. The current report gives details on preliminary research of choosing the location, preparing the equipment and scientific tasks to perform.

Introduction

On 2019 July 2 a total solar eclipse will be visible from within a narrow corridor that crosses throughout the Pacific (the totality will be visible from Oeno Island), Chile, and Argentina. The path of the Moon's umbral shadow will first "touch" the land in Chile and leave the mainland, crossing the Argentina. A partial eclipse will be visible from a much wider band of penumbra of the Moon, which includes much of the Pacific Ocean, across South America, and part of the South Atlantic Ocean.

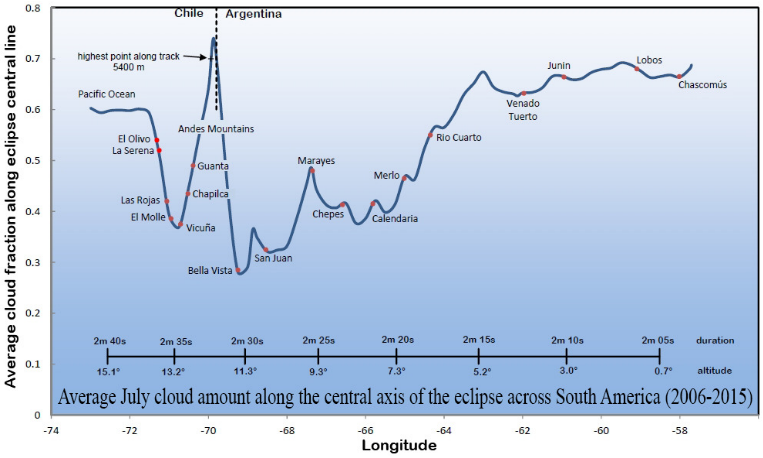
The maximum duration of the total phase of the eclipse will be 4 min 33 s (visible from a territory situated in the Pacific Ocean). For observers from continental land of South America the greatest duration will continue 2 min 36 s (NASA Goddard Space Flight Center:
https://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2019Jul02Tgoogle.html).

All preliminary studies regarding the weather conditions confirm that one of the best places for observations of this eclipse is the Atacama Desert, Chile, where our team will be located (Figure 1a). Using the provided information about the average cloud amount in July along the central axis of the eclipse for the territory of Chile and Argentina, our team chose the best observational spot to be located in the surroundings of the town of El Molle (Figure 1b). Eclipse details for the preferred location are listed in Table 1.

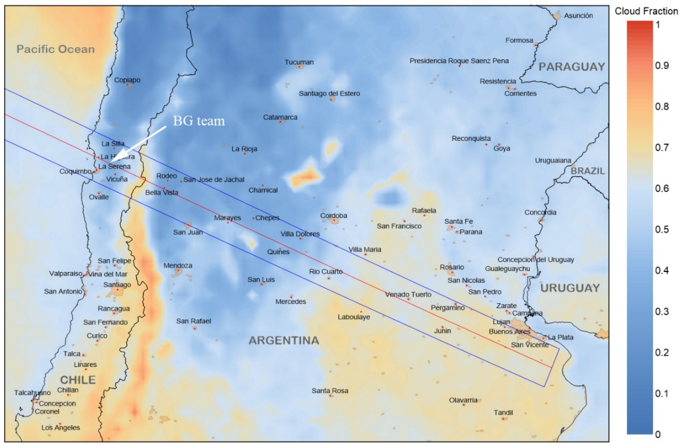
Table 1. Eclipse details for the chosen observational area near El Molle (https://www.timeanddate.com/eclipse/solar/2019-july-2).

Magnitude	Duration [hh:mm:ss]	Duration of the totality [mm:ss]	Maximum [LT]	Sun's altitude at maximum
1.0149	2:23:25	2:32	16:39:47	13.2°

It is important to note that the altitude of the chosen area is in the order of 1000 meters (or more), which contributes to greater transparency of the atmosphere. Our team has chosen a location outside the cities to minimize the effects of light pollution.



a)



b)

Fig. 1 a) Average July cloud amount along the central axis of the eclipse across South America (http://eclipsophile.com/total-solar-eclipse-july-2-2019/); b) Average July afternoon fractional cloudiness along the eclipse track over South America. Data are extracted from 14 years (2002-2015) of observations from the Aqua satellite. (http://eclipsophile.com/total-solar-eclipse-july-2-2019/).

Planned experiments and tasks

a) White-light observations and polarimetric analysis of the solar corona

Polarimetric measurements conducted during TSEs are an important source of information about the physical conditions in the so called white-light corona. During every TSE such measurements are a fundamental experiment in view of the fact that numerous problems related to polarization of the corona are still unsolved [*Badalyan O. G., et al.*, 1997; *Koutchmy S. and Schatten K. H.*, 1971; *Molodensky M. M., et al.*, 2009].

- Searching for areas of polarization in the inner corona which is at a degree, exceeding the maximum possible one, when considering only the Thomson scattering of photosphere photons.
- Investigating electron distribution in solar corona as function of distance from solar center (especially above active regions).
- Determination of the relationship between the degree of polarization and the wavelength.
- Evaluation of the degree of polarization in polar plumes.

b) Fine structure of white-light solar corona

Due to the progress of observing techniques and the usage of modern detectors we now know that the white-light solar corona drives the formation of small-scale structures in the solar corona like helmet streamers or knots. Over the polar regions we have clearly identified the structures of coronal rays and plumes. Observations with a resolution in the order of one arc sec indicate that the majority of the solar corona is in a dynamic state [*Pasachoff J., et al.*, 2007].

- Photographing the solar corona with couple of cameras with different lenses in order to be able to achieve details of coronal fine structure when combine images with different exposure times.

c) Polarimetry of solar prominences

Investigations of quiescent prominences fine structure as well as these on physical parameters like density, temperature or speed are directly connected with underlying magnetic field. Both its global and local components in the environment of prominences are responsible for their lifetime duration. On the other hand, the magnetic reconnection is key factor in destabilization and eruption of filaments. While it is clear that the basis of the dynamics and evolution of solar prominences is related to the local magnetic fields in the area of their occurrence, lots of questions remain unanswered. The planned experiment includes:

- Determination of the parameters of the magnetic field that supports solar prominences, using a polarizing observational method to determine the Sun's magnetic field parameters.
- Obtaining a picture of the global magnetic structure surrounding and supporting the prominences. We aim at showing the existence of coronal voids and/or coronal cavities near prominences and to prove that they are related to the acceleration of the prominence plasma during eruption.

d) Monitoring and recording of "shadows bands"

A yet not fully studied atmospheric phenomenon observed immediately before and after the full phase of a TSE are the so called "shadow bands" [*Codona J. L.*, 1998]. This phenomenon was familiar to astronomers 200 years ago, but its successful photographing and videotaping became possible only in the last three decades. Shadow bands are visible on a flat white surface in the final few seconds before and after the totality of an eclipse. It is clear that this is an atmospheric phenomenon but the part or layer of the atmosphere involved is not yet known. It is largely accepted that it is a result of the light emitted from a thin solar crescent being refracted by the Earth's turbulent atmosphere. We suggest a relatively new experiment for shadow bands exploration.

- Registering the shadow bands using ultrasound anemometers with 4 times per second frequency for measuring the speed of wind.
- Videotaping and registering infrasound signals of this phenomenon. Registering and analysis of infrasound from natural processes in nature is a relatively new scientific branch.

Each eclipse is accompanied by "eclipse wind". The wind speed depends mainly on the regional and local topography, including water surfaces and whether the land is covered by desert, forest or mountains. The landscape also determines rapid changes in temperature which decreases 5-15°C.

- Checking if both the wind and the changes in temperature can cause atmospheric turbulence that is capable to generate very low frequency sound in the atmosphere.
- Monitoring the atmosphere at ground level for low frequency sounds, because their existence would infer that shadow bands are associated with turbulence at all levels of the Earth's atmosphere. For the purposes of this experiment, we will employ a highly sensitive infrasound microphone with a frequency response of 0.1 to 10000 Hz.

Conclusions

We present a preliminary program for observations of 2019 July 2 total solar eclipse visible from the territory of South America. Our team chose a location to obtain the observations situated in the surroundings of Chilean town El Molle with altitude higher than 1000 m above the sea level.

The planned experiments include photographing solar corona with different instruments (lenses and filters) and settings (exposure times, diaphragms, light sensitivities, etc.), as well as registering the properties of atmospheric phenomena that accompany the totality – eclipse winds and shadow bands.

The obtained results will be compared with the ones that we have from similar experiments, held at 2017 August 21 total solar eclipse in USA.

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